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Mission Possible: ALL Species Foundation and the Call for Discovery

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With approximately 1.7 million species currently named and as many as 9 to 99 million more to go, it is clear that there is a lot yet to be known about Earth's biodiversity. In 2000, the non-profit ALL Species Foundation was formed to call for the discovery, identification, and description of all the remaining species on Earth within one human generation — 25 years. ALL Species attracted proponents quickly and was embraced by the taxonomic community for its bold and audacious approach and the potential of new funding. ALL Species' global scientific endeavor is distributed on a wide geographical scale with diverse multinational participants. ALL Species endorses the principles and application of industrial business methods to biological inventory. ALL Species supports the knowledge of all species for all people. Unable to raise significant new funds for discovery, ALL Species reduced in 2002 to one staff member and shifted emphasis to promotion of tools and technology that accelerate the practice of taxonomy (e.g., digital imaging of type specimens, field-based microbiology equipment and molecular field sequencers, pattern recognition software, data rich identification keys, rapid publishing, and comparator tools). The mission? Possible.

The ALL Species Foundation began as an intellectual discussion among friends and rapidly grew into a project with the endorsement of approximately 100 prominent scientists from around the world. The mission: to accelerate the discovery of the planet's entire biodiversity in 25 years — one human generation.

What is ALL Species?

ALL Species is a decentralized and non-bureaucratic global initiative, based on science-driven business models, and affiliated with entrepreneurial and catalytic scientists. Its purpose is to promote and accelerate the collection and systematic analysis of all biodiversity information and make it freely available on the internet.

How Many Species are Out There?

Most scientists accept that about 1.7 million species have been named and described over the last 250 years, yet estimates of how many species exist on Earth vary from 10 to 100 million. The huge range between these last two numbers keenly demonstrates the immensity of the knowledge gap — we don't even know what we don't know.

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If we accept the fact that there are 6000–7000 practicing taxonomists describing two new species a year, the current rate of description is 15,000 per year. At this rate, describing 10 million new species will be completed in 2555. Obviously, a lot has to change to describe what remains within the timeframe challenge of ALL Species. For reasons outlined in this short paper, this rate of taxonomic discovery does not equate to the global significance of biodiversity.

What are the Priorities of Scientific Discovery to Biologists?

Most biologists believe the current extinction rate exceeds background and that Earth faces a "biodiversity crisis" due almost exclusively to human activities. This drives the imperative to know all species before many wink out of existence. Humans are a deeply curious species, but the dichotomy between our complacent acceptance of knowing only ten percent of life on Earth and our well-funded quest to discover life somewhere else in the universe is troubling. As far as we can tell, space is not under the same threat as Earth. Think about these incongruities:

- If you were sick with a life-threatening illness, would you want your physician to know only ten percent of the possible ways to save you; or possess only ten percent of the ability to diagnose what disease ails you?
- Would you hire an investment manager whose financial knowledge spectrum was only ten percent; someone who only read ten percent of the *Wall Street Journal*; someone whose advice was limited to a mere ten percent of the potential stock options available to you?
- What good is a library if you have access to only ten percent of what is there, whereas the remaining 90 percent is closed due to lack of funding; or even more disturbing, this resource is closed due to lack of use?
- What CEO of a corporation makes short-term or long-term buying, selling, or production decisions knowing only ten percent of its inventory or ten percent of its market? The life expectancy of a CEO in this position is highly endangered.

If enough energy and funds were dedicated to an Earth life search, ALL Species and its advisors believe the mission could be accomplished in 25 years. What if just a portion of the billions of dollars spent on SETI or NASA was redirected towards the search for life on Earth for the next 25 years? Many of the same creative scientists and engineers could be utilized to design sophisticated sampling robots for harsh earth environments, imaginative field- and lab-oriented tools for discovery, sequencing, and identification, and novel approaches to information analysis and storage.

Why Does Knowing All Species Matter?

The impact of knowing all species, or most species at least, would be profound. Nearly every useful compound, food, fiber, or process used by humans was produced from either an idea inspired by observation of the natural world or by direct manipulation of some biological object or activity (Beattie and Ehrlich 2001). In the United States alone, 56 percent of the top 150 prescribed drugs is linked to discoveries made in the wild, yet less than one percent of the estimated 250,000 tropical plants has been screened for pharmacological properties (UNEP 2002).

Both biomimicry and nanotechnology are revolutionizing how we invent, compute, heal, harness energy, repair, conduct business, and feed the world. Research conducted at numerous labs around the world concentrates on the development of new products and materials derived from marine and terrestrial organisms. Some of these products or materials include new enzyme catalysts, novel bioadhesives, improved biosensors, optoelectric/catalytic and microelectronic devices, and microlaminate composites (Marine Biotechnology Center, University of California Santa

Barbara website). The discovery of more species equates to more models to observe and more sources to tap for scientific breakthroughs to improve the quality of life (Benyus 1997). Molecular level assays (receptor binding and enzyme inhibition) offer brand new perspective and potential for nature as a source of new pharmacologies (Verpoorte 2003).

Evolutionary biologists and ecologists have different perspectives than the average citizen about why knowing all species matters. From the scientific point of view, understanding biological mechanisms and evolutionary and ecological relationships is the best way to inform conservation and management decisions. This understanding is the best support for accurate priority setting and sustainable environmental policy. As E.O. Wilson says, knowing all species represents the true maturation of biology.

Actually, knowing all species ultimately represents long-term security for *Homo sapiens*. All agree that bio-security certainly has new meaning since 9/11. Pests and diseases are shared globally at an unprecedented level. Yet we know very little about species interactions that affect crop yields or the life cycles of vectors and the predators of vectors. Some believe that the most threatening crisis humanity faces is antibiotic-resistant bacteria in our own hospitals. However, it is significantly odd that the number of protist taxonomists remains very small relative to the number that study birds or plants.

Why is the Mission Possible Now?

Many of the past impediments to global species discovery have been eliminated with modern advancements. Driven by Moore's Law, the continued exponential development of technologies and their decreasing cost over time provides the threshold for today's scientists to identify all life on Earth in their lifetime. Progress will be slow at first but once the inflection point of the curve occurs, mo-mentum will gather speed. Table 1 lists some of the reasons why ALL Species ad-visors believe the mission is possible within the 25-year time frame.

Table 1. Some of the reasons why ALL Species advisors believe the mission is possible within the 25-year time frame

Past Impediments	*Current Solutions*
Travel difficulty	Advances in transportation
Glacial pace of information transfer	Internet
Access to collections/library	Online databases
Need to physically examine type specimens	Digital images reduce need
Delay/expense in publication	E-publishing
Limited compare/analyze tools	Rapid sequencing/Phylogenetics
Few experts	Capacity building initiatives

What Has to Happen to Find ALL Species?

For ALL Species' mission to succeed, societal changes must occur. National and international leadership must be demonstrated and pressure must be exerted upwards from the biological community about the value of taxonomy and the value of discovery. Barring a cautionary catastrophe that would inject a crisis mentality and jump start these changes, a critical fundament to the requirements is an abundance of 21st century thinking. Of course, the mission requires substantial funds, but almost more importantly it also requires:

- Evolution of the practice of taxonomy and systematics
- New tools, technologies, and training
- Unprecedented knowledge transfer to megadiverse countries

- A new corps of taxonomists
- Transformation of the culture within natural history sciences
- Increased public awareness

What is the History and Current Status of ALL Species?

From its inception in 2000, ALL Species has seen itself as a neutral instigator and catalyst, a promoter and broker, and a fundraiser. After two international meetings in 2001 that framed the scope of the mission, advisory and governing boards were established. The advisory boards helped identify the first five-year goals that would either accelerate the process of taxonomy or provide testing ground for field inventory methods and protocols. These goals are listed in Table 2.

Table 2. The first five-year goals that would either accelerate the process of taxonomy or provide testing ground for field inventory methods and protocols

First Five-Year Goals of ALL Species
Image and web enable 50 percent of the primary type specimens
One global inventory of a taxonomic group
Quadruple the rate of species description
One comprehensive all-taxa biodiversity inventory
Increase the taxonomic capacity of developing nations twofold

Funding from The Schlinger Foundation in 2001 allowed the hiring of a small staff that set about forging partnerships and supporters to frame the discussion about how best to accomplish the mission. This staff also began creating tools to accelerate the business of taxonomy — such as a search engine. Within three months, this search engine <*http://www.speciestoolkit.org/index.jsp*> became the largest publicly available resource indexing a total of 873,979 species and 1,124,819 names. Full design and deployment of the Toolkit were put on hold in November 2002. However, the code is freely available under the GNU Public License at SourceForge at <*http://speciestoolkit.sourceforge.net/*> where the code and more extensive documentation are available. The ALL Species staff also designed and promoted a prototype Encyclopedia of Life — a consolidation of all biological information about species where every species has a web page and every web page is a portal to varying levels of biodiversity information about that species — from specimens to identification keys to experts to distribution maps.

ALL Species hosted one digital imaging workshop at the California Academy of Sciences during spring of 2002. From the success of that workshop, the E-Type and E-Description Initiative was launched — an effort to spearhead the digital imaging of primary type specimens and its original literature when possible. Through NSF supplemental funding, ALL Species co-hosted two E-Type Initiative Strategic Workshops at the Smithsonian (November 2002 and May 2003) where researchers from the major collections in the United States and Europe and the developing world discussed the benefits and goals of the Initiative and mapped preliminary strategies for the Initiative and for specific taxon groups.

Unable to raise significant additional funds for the young organization with big ideas, ALL Species was reconfigured in late 2002. Hoping to keep the mission alive until a more auspicious economic climate, four institutions stepped forward to provide support for one staff person to concentrate on the E-Type and E- Description Initiative and other ALL Species activities through 2003 and possibly into 2004: California Academy of Sciences, Field Museum, Missouri Botanical Gardens, and Museum of Comparative Zoology — Harvard. ALL Species' advisory boards remain active on a volunteer basis.

As of June 2003, ALL Species had met with considerable success on at least two of these first goals. Through Conservation International, a one-year all-taxa biodiversity inventory is slated to

occur in Los Amigos, Peru following protocols and methodologies designed by Terry Erwin of the Smithsonian (former ALL Species Science Chair). At the instigation and urging of ALL Species, in 2002 the National Science Foundation launched a brand new $14 million program called Planetary Biodiversity Inventories (PBI) to support the global inventory of major taxonomic groups. The first four awards will cover catfish, eumycetozoans (slime molds), solanum (nightshade family of plants), and plant bugs. Even in its reduced state, ALL Species was able to contribute $25,000 to the PBI effort.

Is the Mission Possible?

Every biologist needs to be part of this mission whether they are an ALL Species advisor, a previously quiet supporter at the sidelines, or someone reading this text by accident. We all need to promote the need to know. Each of us needs to take every opportunity wherever we can to stress the value of discovery and the value of knowing, and to broadcast the importance of taxonomy and taxonomic products to society. Useful new tools and developments that accelerate the practice of taxonomy need to be fostered and promoted. In short, ALL Species challenges each of us to become biodiversity diplomats. We need to coordinate across disciplines and to collaborate at new levels. We need to speak up and speak out and to mobilize. Is the mission possible?

Only if we each follow Mahatma Gandhi's advice and "Be the change you wish to see in the world."

Update: August 2004

Unfortunately and anticlimactically, ALL Species is currently without staff and the foundation is dormant. Attempts over the past six months to find an organization in the mutually strategic position to adapt the assets of ALL Species have been unsuccessful. The good news is that E-typing is far more common and the Smithsonian's new Encyclopedia of Life will take ALL Species' and E.O. Wilson's idea of a web page for every species and try to make it happen.

So, the vision will continue, for after ALL, vision is what makes any mission possible.

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